



U.S. NUCLEAR REGULATORY COMMISSION
STANDARD REVIEW PLAN
OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 10.2

TURBINE GENERATOR

REVIEW RESPONSIBILITIES

Primary - Auxiliary and Power Conversion Systems Branch (APCSB)

Secondary - Reactor Systems Branch (RSB)
Mechanical Engineering Branch (MEB)
Materials Engineering Branch (MTEB)
Radiological Assessment Branch (RAB)
Electrical, Instrumentation and Control Systems Branch (EICSB)I. AREAS OF REVIEW

Nuclear reactor plants include a turbine generator system (TGS) to convert the energy in steam from the nuclear steam supply system into electrical energy. The TGS consists essentially of the turbine unit and the automatic devices, alarms, and trips which control and regulate turbine action, and the generator unit and its controls. The turbine control system and the steam inlet stop and control valves, the low pressure turbine steam intercept and inlet control valves, and the extraction steam control valves control the speed of the turbine under normal and abnormal conditions, and are thus related to the overall safe operation of the plant.

The turbine generator systems installed in nuclear plants are typically equipped with redundant overspeed protection instrumentation and controls and the main steam and reheat steam control and stop valving arrangements typically provide redundancy in the valves essential for overspeed protection. The intent of the review under this plan is to verify that such redundancy, in conjunction with inservice inspection and testing of the essential valves, makes a turbine overspeed condition above the design overspeed very unlikely. Assessment of the risk to essential plant systems and structures from potential turbine missiles is reviewed under SRP 3.5.1.3.

1. The APCSB reviews the turbine generator system and the components and subsystems normally provided with this equipment with respect to the following considerations:
 - a. The general arrangement of the turbine and associated equipment with respect to safety-related structures and systems and balance of plant.

USNRC STANDARD REVIEW PLAN

Standard review plans are prepared for the guidance of the Office of Nuclear Reactor Regulation staff responsible for the review of applications to construct and operate nuclear power plants. These documents are made available to the public as part of the Commission's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Standard review plans are not substitutes for regulatory guides or the Commission's regulations and compliance with them is not required. The standard review plan sections are keyed to Revision 2 of the Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants. Not all sections of the Standard Format have a corresponding review plan.

Published standard review plans will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience.

Comments and suggestions for improvement will be considered and should be sent to the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Washington, D.C. 20555.

11/24/75

9511020105 751124
PDR NUREG
75/087 R PDR

- b. The types and locations of main steam stop and control valves, reheat stop and intercept valves, and associated piping arrangements.
 - c. The capability of the turbine generator control and overspeed protection systems to detect a turbine overspeed condition and to actuate appropriate system valves or other protective devices to preclude an overspeed condition above the design overspeed.
2. The inservice inspection and operability assurance program for valves essential for overspeed protection is reviewed.
 3. The applicant's proposed technical specifications are reviewed for operating license applications as they relate to areas covered in this review plan.

Secondary reviews are performed by other branches and the results used by the APCSB to complete the overall evaluation of the system. The secondary reviews are as follows: the RSB determines that appropriate seismic and quality group classifications have been established for system components where appropriate. The MEB confirms that the components, piping, and structures are designed in accordance with applicable codes and standards. The MTEB verifies that inservice inspection requirements are met for system components, and will verify the compatibility of the materials of construction with service conditions. The RAB determines if any radiation shielding is necessary to assure safe access to turbine equipment. The EICSB reviews the overspeed protection instrumentation and controls with respect to capabilities, reliability, and redundancy.

II. ACCEPTANCE CRITERIA

There are no general design criteria or regulatory guides that are directly applicable to the design evaluation of the turbine generator. Acceptability of the design of the turbine generator system, as described in the applicant's safety analysis report (SAR), is based on the specific criteria listed below and on the similarity of the design to that of plants previously reviewed and found acceptable.

1. A turbine control and overspeed protection system should be provided to control turbine action under all normal or abnormal operating conditions, and to assure that a full load turbine trip will not cause the turbine to overspeed beyond acceptable limits. Under these conditions, the control and protection system should permit an orderly reactor shutdown either by use of the turbine bypass system and main steam relief system or other engineered safety systems. The overspeed protection system should meet the single failure criterion.
2. Turbine main steam stop and control valves and reheat steam stop and intercept valves should be provided to protect the turbine from exceeding set speeds and to protect the reactor system from abnormal surges. The reheat stop and intercept valves should be capable of closure concurrent with the main steam stop valves, or of sequential closure within an appropriate time limit, to assure that turbine overspeed is controlled.

within acceptable limits. The valve arrangements and valve closure times should be such that a failure of any single valve to close will not result in excessive turbine overspeed in the event of a TGS trip signal.

3. Extraction steam stop valves should be provided at each extraction connection. The valves shall be capable of closing within an appropriate time limit to maintain stable turbine speeds in the event of a TGS trip signal.
4. The TGS should be provided with the capability to permit periodic testing of components important to safety while the unit is operating at rated load.
5. The inservice inspection program for main steam and reheat valves should include the following provisions:
 - a. At approximately 3-1/3-year intervals, during refueling or maintenance shutdowns coinciding with the inservice inspection schedule required by Section XI of the ASME Code for reactor components, at least one main steam stop valve, one main steam control valve, one reheat stop valve, and one reheat intercept valve should be dismantled and visual and surface examinations conducted of valve seats, disks, and stems. If unacceptable flaws or excessive corrosion are found in a valve, all other valves of that type should be dismantled and inspected. Valve bushings should be inspected and cleaned, and bore diameters should be checked for proper clearance.
 - b. Main steam stop and control valves and reheat stop and intercept valves should be exercised at least once a week by closing each valve and observing by the valve position indicator that it moves smoothly to a fully closed position. At least once a month, this examination should be made by direct observation of the valve motion.
6. Unlimited access to all levels of the turbine area under all operating conditions should be provided. Radiation shielding should be provided as necessary to permit access.
7. Connection joints between the low pressure turbine exhaust and the main condenser should be arranged to prevent adverse effects on any safety-related equipment in the turbine room in the event of rupture (it is preferable not to locate safety-related equipment in the turbine room).
8. Branch Technical Position APCSB 3-1 should be used to determine the acceptability of the effects of postulated TGS piping failures on safety-related equipment.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and preliminary design as set forth in the preliminary safety analysis report meet the acceptance criteria given in Section II of this plan. For review

of operating license (OL) applications, the procedures are utilized to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report.

The review procedures for OL applications include a determination that the content and intent of the technical specifications prepared by the applicant are in agreement with the requirements for system testing, minimum performance, and surveillance developed as a result of the staff's review.

The review procedures given are for a typical turbine generator system. Any variance of the review, to take account of a proposed unique design, will be such as to assure that the system meets the criteria of Section II. The reviewer evaluates the TGS, subsystems, and components of the unit that are considered essential for the safe integrated operation of the reactor facility. The reviewer will select and emphasize material from this review plan, as may be appropriate for a particular case.

1. The SAR is reviewed to determine that the system description and piping and instrumentation diagrams (PID's) show the turbine generator system. The general arrangement of the TGS and associated equipment with respect to safety-related structures, systems, and components is noted.
2. The reviewer consults with the EICSB to verify the adequacy of the control and over-speed protection system and to determine that:
 - a. Support systems, subsystems, control systems, and alarms and trips will function for all abnormal conditions, including a single failure of any component or subsystem, and will preclude an unsafe turbine overspeed. The indepth defense that is provided by the turbine generator protection system to preclude excessive overspeeds should be designed with diverse protection means.
 - b. For normal speed-load control, the speed governor action of the electro-hydraulic control system fully cuts off steam at approximately 103 percent of rated turbine speed by closing the control, stop, and intercept valves.
 - c. A mechanical overspeed trip device is provided that will actuate the control, stop, and intercept valves at approximately 111 percent of rated speed.
 - d. An independent and redundant backup electrical overspeed trip circuit is provided that senses the turbine speed by magnetic pickup and closes all valves associated with speed control at approximately 112 percent of rated speed. This backup electrical overspeed trip system may utilize the same sensing techniques as the electro-hydraulic control system. However, the circuitry is reviewed to determine that the control signals from the two systems are isolated from and independent of one another.

3. The main steam stop and control and the reheat stop and intercept valving arrangements and valve closure times are reviewed to ensure that no single valve failure can disable the overspeed control function.
4. The extraction steam valving arrangements and valve closure times are reviewed to see that stable turbine operation will result after a TGS trip.
5. The capability for testing of essential components during TGS operation is reviewed.
6. The proposed inservice inspection program for essential speed control valves is reviewed to verify that it includes the provisions of item 5 of Section II.
7. The reviewer consults with RAB with regard to expected radiation levels around the TGS and the degree of access to TGS components during operation.
8. If there are safety-related systems or portions of systems located close to the TGS, the physical layout of the system is reviewed to assure that protection has been provided from the effects of high and moderate energy TGS piping failures or failure of the connections from the low pressure turbine section of the main condenser. The means of providing such protection will be given in Section 3.6 of the SAR, and the procedures for reviewing this information are given in the corresponding review plans.

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided and his review supports conclusions of the following type, to be included in the staff's safety evaluation report:

"The turbine generator system includes all components and equipment normally provided including turbine main steam stop and control valves and reheat steam stop and intercept valves. The scope of review of the turbine generator system for the _____ plant included layout drawings, piping and instrumentation diagrams, and descriptive information for the system and for control and supporting systems that are essential to its operation. [The review has determined the adequacy of the applicant's proposed design criteria and bases for the turbine generator system and the requirements for safe operation of the system during normal, abnormal, and accident conditions. (CP)] [The review has determined that the design of the turbine generator system and supporting systems is in conformance with the design criteria and design bases. (OL)]

"The basis for acceptance in the staff review has been conformance of the applicant's designs, design criteria, and design bases for the turbine generator system and supporting systems to applicable staff technical positions and industry standards.

"The staff concludes that the design of the turbine generator system conforms to all applicable staff positions and industry standards, and is acceptable."

V. REFERENCES

1. Branch Technical Position APCS8 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," attached to Standard Review Plan 3.6.1.

SRP 10.3